Sun Fire™ X4100 M2 and X4200 M2 Server Architectures

A Technical White Paper

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Introduction

Building A Smarter, More Powerful Infrastructure

IT organizations are constantly under pressure to improve operations and get more work done while lowering costs. Often constrained by technology barriers, IT managers strive to gain efficiencies by standardizing platforms and procedures. Unfortunately, these efforts stall as data centers are often stocked with a mix of new 64-bit applications and a large inventory of 32-bit code which require a variety of different chip architectures and operating environments for execution. As a result, organizations are forced to purchase separate, incompatible servers for each type of application. This multi-platform scheme reduces flexibility and increases management and acquisition costs. Adding to platform related frustrations, enterprises frequently deploy faster processors in an attempt to speed up software, but hardware architectures with high memory latencies and I/O bottlenecks limit the gains realized at the application level.

At the same time, the total number of servers in the data center continues to increase at a rapid pace, pushing facilities and system management plans to the breaking point. Many of these systems contain high frequency processors which require more power and run hotter than previous generations of servers. In addition to increased energy costs, proper power and cooling of full racks of these systems is impossible, and valuable floor space is lost as technicians are forced to leave racks largely empty to maintain airflow. Once systems are finally racked and powered, organizations strain to find scalable methods to cost effectively monitor and maintain so many servers.

To help these efforts, enterprises are looking for smarter options for building a cost effective, powerful infrastructure based on standardized components. Sun Fire™ x64 systems reduce cost and complexity by providing a universal platform that simultaneously runs 32-bit and 64-bit applications at full speed on a choice of operating systems, including the Solaris™ Operating System (OS), Linux, and Windows. These modular, rackmount servers are designed to Sun's exacting standards to take full advantage of the exceptional power of AMD Opteron™ processors and the AMD Direct Connect Architecture, resulting in significantly greater performance than comparable servers with Intel Xeon processors.

In addition, Sun Fire x64 servers run cooler and require less power than comparable platforms from other suppliers, delivering significant energy savings and the ability to preserve expensive data center floor space by stacking servers tightly into racks. Adding even more value, Sun Fire x64 servers integrate lights out management with in-band and out-of-band control, improving service levels and reducing operational costs.

Figure Intro-1: Sun Fire X4100 M2 and X4200 M2 Servers

Customers seeking a business edge can look to Sun to provide smarter options for building a simple, secure, standardized IT infrastructure. The Sun Fire x64 family of servers are smart solution enablers for standardizing the datacenter – a high-performance set of servers that offer the unity of vertical scaling with the economies of horizontal scaling, while running any major OS and 32-bit/64-bit application. Sun continues its efforts to provide customers with solutions to help them realize the benefits of a horizontal infrastructure (lower incremental CPU cost, OS flexibility) while reducing the hidden costs and complexities.

Sun Fire X4100 M2 (1RU) and Sun Fire X4200 M2 (2RU) were the two initial members of the Sun Fire x64 family, a new line of servers designed to improve the economics of x64 systems while setting new standards for performance, reliability, and energy efficiency by reducing cost and complexity while delivering Sun's rock-solid enterprise-class capabilities and quality. Both are high-performance, single- or dual-socket platforms with single- or dual-core processors in a 1RU or 2RU package. Both use the same hot-swappable power supplies, hot-swappable hard disk drives, CPUs, memory, and Service Processor. The use of common components across the entire server line requires fewer spare parts on hand, lowering operational costs. Table 1-1 shows the maximum configurations supported by each server.

Table 1-1: Sun Fire X4100 M2 and X4200 M2 Maximum Configurations

	Sun Fire X4100 M2	**Sun Fire X4200 M2**
# of sockets supported	2	
# of memory slots	8 DIMMS (4 slots per socket)	
Maximum memory	32 GB using 4 GB DIMMS	
# of hard disks supported	2 disks + DVD OR 4 disks with no DVD	4 disks + DVD
# of Expansion slots	2 PCI-E	4 PCI-E + 1 PCI-X

Sun Fire X4100 M2 and X4200 M2 servers feature redundant, hot-swappable fan modules and redundant, hot-pluggable AC power supplies to enable increased availibility and simplified serviceability. Both systems support a consistent I/O feature set that includes four (4) 10/100/1000BaseT Gigabit Ethernet ports, a four-channel SAS RAID 0/1 disk controller with integrated mirroring, video, USB ports (Sun Fire X4100 M2: one front, two rear and Sun Fire X4200 M2: two front, two rear), and a dedicated serial and 10/100BaseT Ethernet remote management port. For further expansion, the Sun Fire X4100 M2 provides two (2) low-profile PCI-Express slots and the Sun Fire X4200 M2 provides four (4) low-profile PCI-Express slots and one (1) PCI-X slot for high-performance application I/O. Single- and dual-core AMD Opteron CPUs are supported to provide a flexible, high-performance growth path and investment protection 32-bit applications are protected while still enabling seamless migration to 64-bit applications.

The Sun Fire x64 server family also includes an extensive set of RAS (Reliability, Availability, and Serviceability) features which reduce hidden serviceability costs by dramatically simplifying system maintenance. In addition, the Sun Fire x64 family of servers provides remote lights out server management, including remote keyboard, video, mouse, and storage (RKVMS); remote boot; and remote software upgrades using the Integrated Lights Out Manager (ILOM) Service Processor.

Chapter 1

Flexible, High Speed x64 Architecture

Innovation and technology leadership combine within the Sun Fire x64 server family to deliver some of the most flexible, high performance systems ever created. With the ability to run 32-bit and 64-bit applications on a single high speed platform, Sun Fire x64 servers address the real challenges and bottlenecks found in many system architectures, and deliver world record benchmark results.

A Universal Computing Platform

For years, organizations refrained from adopting 64-bit computing in a pervasive manner. With the majority of applications still based on 32-bit code and budgets as constrained as ever, expensive 64-bit systems which emulated 32-bit execution environments did not provide sufficient performance, flexibility, and investment protection. The need for a revolutionary low cost platform that could ease the adoption of 64-bit computing was evident. The x64 architecture implementation from AMD, also known as AMD64, paved the way forward by producing a cost conscious x86-compatible instruction set that provides for simultaneous 32- and 64-bit computing. As a result, existing 32-bit applications and operating systems run at peak performance, while providing a 64-bit capable migration path. This instruction set is implemented on the AMD Opteron processor used by all Sun Fire x64 servers. By leveraging the x64 architecture, Sun Fire x64 servers create a new class of computing which enables organizations to build solutions based upon today's needs without barriers to future innovations.

Key to the x64 architecture, the x64 Instruction Set Architecture (ISA) simply extends the existing x86 ISA and natively executes 32-bit code emulation modes which tend to degrade performance are not needed. Benefiting both 32-bit and 64-bit applications, the x64 ISA enables continued performance scaling for applications that demand multiprocessor scalability or larger addressable memory. In addition, true 64-bit applications experience gains in multimedia performance and improvements in computational accuracy. The x64 ISA is designed for applications that:

- Need large memory addressing to handle datasets larger than 3 GB per process, such as financial and scientific modeling applications.
- Need to manage a large number of concurrent users or application threads, such as large-scale, thin-client solutions, large databases, data warehousing applications for solutions in customer relationship management (CRM), supply chain management (SCM), enterprise resource planning (ERP), and digital rights management (DRM) systems.
- Require real-time encryption and decryption for enhanced security, including e-commerce and the protection of private or classified data.
- Require mathematical precision and floating-point performance, including modeling, simulation, statistics and financial analysis, imaging, video, and signal processing, physics, medical research, telecommunications, encryption, and compression.
- Require large, high power database performance, including decision support, searching and indexing, document and content management, and voice recognition.
- Require x86 compatibility or the economies of scale of x86 systems, as well as the large memory addressingcapabilities of 64-bit computing, including many high performance computing (HPC) cluster applications.

- Provide digital content creation capabilities, such as computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-aided engineering (CAE), digital music production and video editing, and real-time media streaming solutions.
- Require maximum performance for rendering of realistic and cinematic scenes for use in computer generated cinema, next generation computer games, and various digital and real time video processing applications.

Compatibility with the x86 architecture makes the x64 computing platform the first 64-bit platform designed to run mainstream PC applications while offering world-class performance at an affordable price. This technology is suitable for solutions ranging from consumer PCs to high performance clusters. The flexibility and scalability offered by x64 computing provides organizations with enhanced investment protection as this single architecture addresses a broad range of current and future capability and performance requirements.

Breaking Away with the AMD Direct Connect Architecture

There is more to the exceptional performance of Sun Fire x64 systems than simply a processor and instruction set. The use of the AMD Direct Connect Architecture offers enterprises a superior x64 platform over traditional x86 Northbridge/Southbridge designs. Instead of a system bus which shares bandwidth among all motherboard components, the AMD Direct Connect Architecture directly connects the processors, memory controller, and I/O to the CPU to enable overall system performance and efficiency. Directly connected CPUs provide more linear, symmetrical multiprocessing. A memory controller directly connected to a CPU optimizes memory performance, while directly connected I/O provides more balanced throughput and performance. Dual-core processors extend the benefits of the AMD Direct Connect Architecture by connecting two CPU cores to each other on one die to reduce latencies between cores.

HyperTransport Technology

HyperTransport technology is the high speed, high performance, point-to-point link employed by the AMD Direct Connect Architecture to provide a scalable direct connection between processors, I/O subsystems, and other chipsets. It connects the I/O to the processors at a rate of 8 GB/second aggregate bandwidth per link. These capabilities enable HyperTransport technology to help reduce the number of buses in a system, which in turn can help reduce system bottlenecks and enable today's faster microprocessors to use system memory more efficiently.

HyperTransport technology:

- Helps increase overall system performance by removing I /O bottlenecks typically found in Front Side Bus (FSB) architectures and efficiently integrating with legacy buses, increasing bandwidth and speed, and reducing processor latency.
- Provides up to 8 GB/second bandwidth per link at 16x16 bits, 1 GHz operation, providing sufficient bandwidth for supporting new interconnects, such as PCI-Express.

Memory Interface

In traditional x86 Northbridge/Southbridge architectures, processors share a memory controller and are not directly connected to

one another. Memory transactions must propagate through the Northbridge chip fabric which also carries I/O traffic. This can present a bottleneck at the front-side bus that greatly reduces productivity and performance potential. In the AMD Direct Connect Architecture, each CPU has its own integrated memory controller, fostering more linear, symmetrical multiprocessing and optimized memory performance. This direct connection to the memory controller significantly reduces the memory latency seen by the processor. Latency continues to drop as the processor frequency scales.

Additionally, hardware and software memory pre-fetching mechanisms can further reduce the effective memory latency seen by the processor. This reduction in memory latency, coupled with the additional increase in memory bandwidth enabled by a directly connected processor, presents a critical advantage as it greatly enhances system performance across all application segments.

I/O Expansion Capability to High Speed Industry Buses

The traditional Northbridge/Southbridge architecture is not intended to support more than two core-logic elements. Adding additional high speed functionality, such as Gigabit Ethernet, PCI-Express, or the InfiniBand architecture, can impact system performance and cost. HyperTransport technology provides system designers with a high speed interconnect between system components. These elements connect in a building block fashion to achieve a platform with specific feature set and performance objectives.

Chapter 2

Sun Fire X4100 M2 and Sun Fire X4200 M2 Architecture Overview

Sun Fire X4100 M2 Server

The Sun Fire X4100 M2 server measures 1 rack-unit (RU) high (or 1.72 inches/43.8 mm) 17.5 inches (445 mm) wide, and 25.2 inches (640 mm) deep. It is a rack-optimized, x64-based system with a symmetric multiprocessor. Cooling is accomplished with internal fans that direct airflow from the front to the back of the chassis. I/O ports are located on the rear panel, with an additional USB on the front panel. Access to the power connections is at the rear of the server. Hard drives and optical storage are accessible from the front of the server.

The Sun Fire X4100 M2 server also provides the following system architecture features:

- Two AMD Opteron 2200 Series processors with integrated dual-channel DDR2 memory controllers on each CPU to provide maximum memory capacity and bandwidth scaling delivering up to 32 GB of capacity and 21.4 GB/sec. of aggregated bandwidth with 2 CPUs populated and four 4 GB DIMMs.
- AMD Direct Connect Architecture that directly connects CPU-to-CPU with 2 HyperTransport links, one of which is cache coherent, and CPU-to-I/O with non-Coherent HyperTransport links delivering 8 GB/sec. aggregate bandwidth per link, , CPU-to-memory using the integrated DDR2 controller, and CPU cores to each other on the same die in dual-core processors
- Two 8-lane PCI-E slots to deliver high-performance I/O with up to 8 GB/sec. of aggregated I/O plug-in bandwidth
- Embedded quad Gigabit Ethernet and a SAS disk controller to leave the two PCI-E slots available for expansion needs
- Embedded management and legacy I/O to offer maximum operational flexibility without compromising PCI slots for optional features

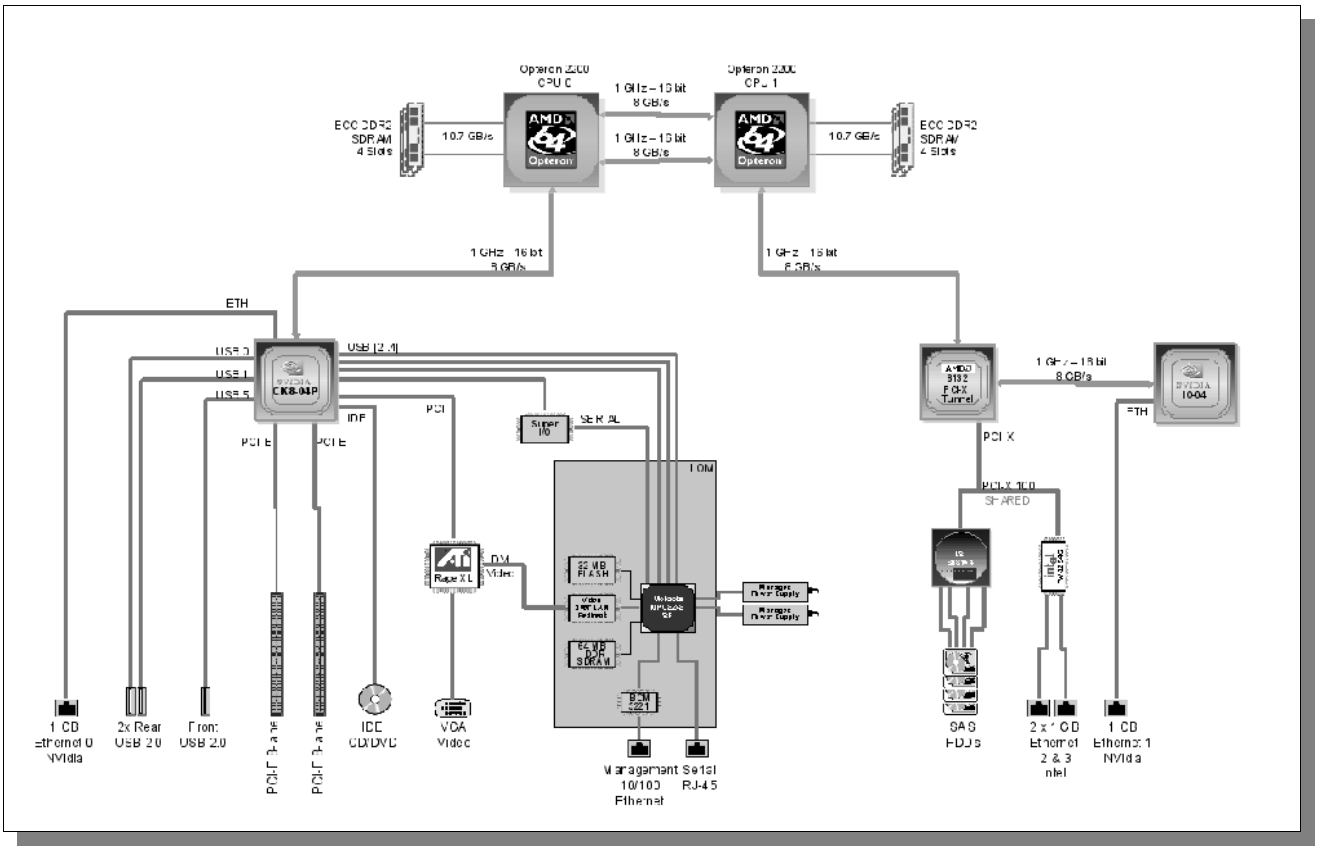


Figure 1-1: Sun Fire X4100 M2 Server Architecture Block Diagram.

Sun Fire X4200 M2 Server

The Sun Fire X4200 M2 measures 2 rack-unit (RU) high (or 3.449 inches/87.6 mm), 17.5 inches (445 mm) wide, and 25.2 inches (640 mm) deep. It is a rack-optimized, x64-based system with a symmetric multiprocessor. Cooling is accomplished with internal fans which direct airflow from the front to the back of the chassis. I/O ports are located on the rear panel, with an additional two USB on the front panel. Access to the power connection is at the rear of the server. Hard drives and optical storage are accessible from the front of the server.

The Sun Fire X4200 M2 server also provides following system architectural features:

- Two AMD Opteron 2200 Series processors with integrated dual-channel DDR2 memory controllers on each CPU to provide maximum memory capacity and bandwidth scaling delivering up to 32 GB of capacity and 21.4 GB/sec. of aggregated bandwidth with 2 CPUs populated and 4 GB DIMMs.
- AMD Direct Connect Architecture that directly connects CPU-to-CPU with 2 HyperTransport links, one of which is cache coherent, and CPU-to-I/O with non-Coherent HyperTransport links delivering 8 GB/sec. aggregate bandwidth per link, , CPU-to-memory using the integrated DDR2 controller, and CPU cores to each other on the same die in dual-core processors

- Four PCI-E and one PCI-X slots deliver high-performance I/O expansion capabilities.
- Embedded quad Gigabit Ethernet and a SAS disk controller to leave the five PCI slots available for expansion needs
- Embedded management and legacy I/O to offer maximum operational flexibility without compromising PCI slots for optional features

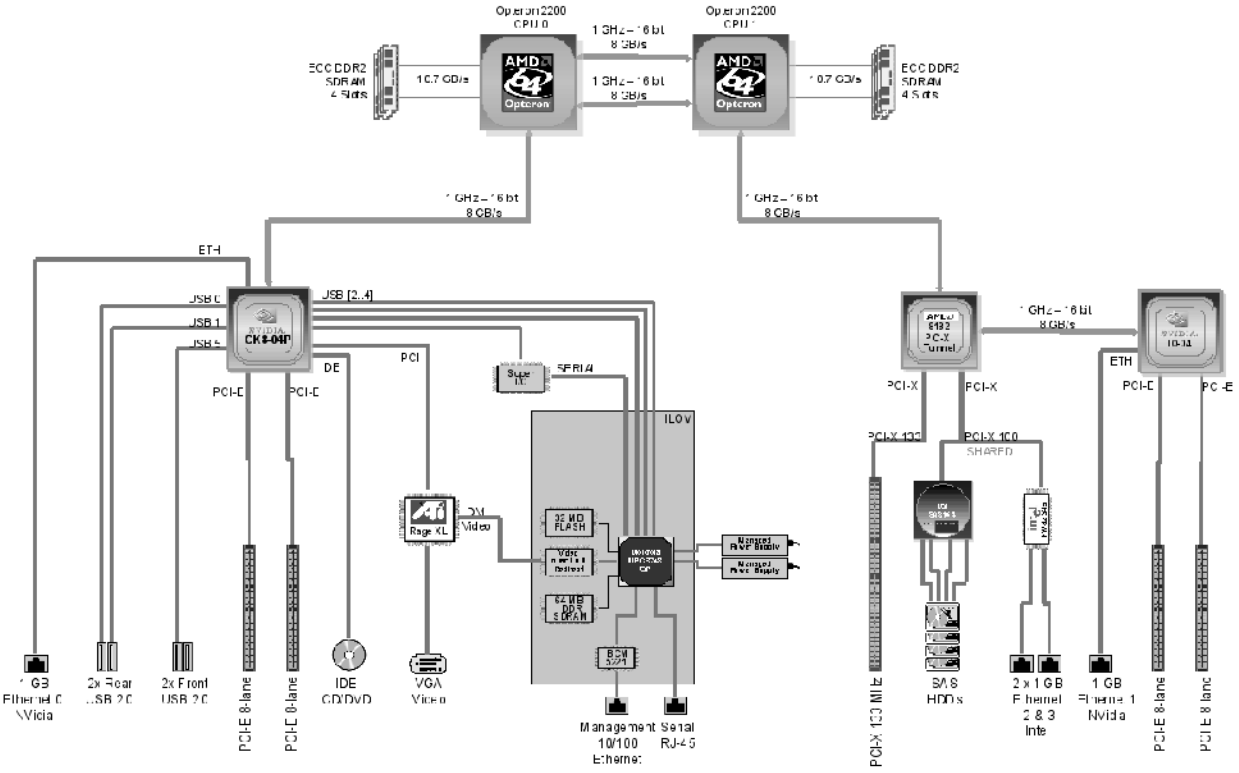


Figure 1-2: Sun Fire X4200 M2 Server Architecture Block Diagram.

Chapter 3
CPU Architecture

The Sun Fire X4100 M2 and X4200 M2 servers support one boot and one optional Dual-Core AMD Opteron Series 2200 processor. The base processor is inserted in physical position CPU0 (the right side socket on the motherboard when viewed from the front of the system). In a dual processor configuration, the CPUs must be of the same model/speed and stepping version. In a single processor configuration, a HT Bridge must be inserted in CPU1 socket in order to ensure HyperTransport continuity between CPU0 and the rest of the IO.

Each processor contains an integrated memory controller supporting a 128-bit wide path to memory and three 16x16-bit HyperTransport links. Each HyperTransport link runs at speeds up to 1 GHz and is clocked on both edges of the clock pulse, allowing for a maximum of 4 GB/sec. (2 gigatransfers/sec., 2 bytes wide) throughput in each direction (8 GB/sec. aggregate data rate bidirectionally). Memory support is for registered DDR2-667 SDRAM DIMMs, four DIMM slots per CPU, accessed in pairs with an available memory bandwidth up to 10.7 GB/sec. (with PC2-5300) per processor. Memory capacity scales with the number of processors. Therefore, memory attached to an unpopulated processor socket is unaddressable. As a result, a single processor machine can support a maximum of four DIMMs. A dual CPU server supports a maximum of eight DIMMS or 32 GB (8 x 4 GB) of memory.

Next Generation AMD Opteron Processor

Features of the AMD Opteron processor in the Sun Fire X4100 M2 and X4200 M2 servers include:

- 1 or 2 Dual-Core AMD Opteron 2200 Series processors
- x64 architecture (64-bit extensions) with AMD Direct Connect Architecture using HyperTransport Technology
- Native support for 32-bit x86 ISA, SSE, SSE2, MMX, and 3DNow!
- Three HyperTransport links supporting up to 8 GB/sec. of direct inter-processor and I/O bandwidth
- ECC protection for L1 data cache, L2 unified cache, and DRAM with hardware scrubbing of all ECC protected arrays
- CPU L1 Instruction cache: 64KB 2-way associative, parity protected with advanced branch prediction
- CPU L1 Data cache: 64KB 2-way associative, ECC protected
- Two 64-bit operations per cycle, 3-cycle latency
- CPU L2 cache: 1MB 16-way associative, ECC protected
- Exclusive cache architecture storage, in addition to L1 caches
- 256 TB of memory address space

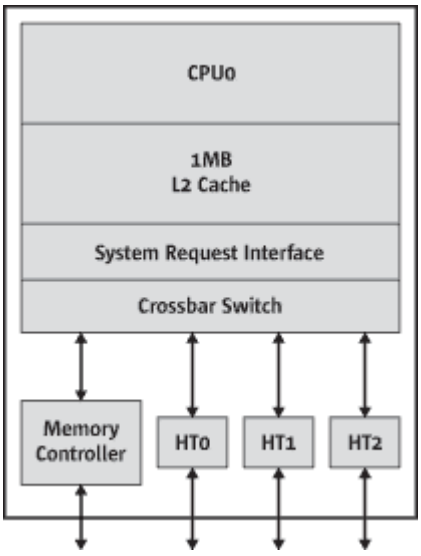


Figure 2-1: Single-Core AMD Opteron Processor Architecture (Stepping E and earlier generations)

The Sun Fire X4100 M2 and X4200 M2 servers support AMD Opteron 2200 Series processors (aka stepping F). From the start, AMD64 processors were designed for multi-core architecture the core being connected to IO via a crossbar/SRI. Dual-core AMD Opteron processors have unique instances of L1 cache (I-cache and D-cache) and L2 cache for each CPU core. Features of the Dual-Core AMD Opteron processor include:

- 1207-pin (socket F) package compatitible with next generation multi-core AMD Opteron processor
- One die with 2 CPU cores
- Individual L1 Instruction cache per CPU core
- Individual L1 Data cache per CPU core
- Individual 1 MB L2 cache per CPU core
- Shared memory controller and HyperTransport interconnects for 2 cores
- Fully utilized memory and HyperTransport bandwidths

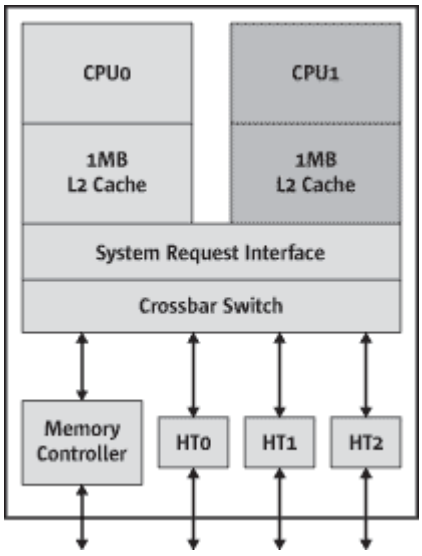


Figure 2-2: Dual-Core AMD Opteron Processor Architecture

Note: Sun Fire X4100 M2 and X4200 M2 servers support both Standard Edition (95W) and Special Edition (120W) of the Next Generation AMD Opteron processor.

Processor VRM

Each processor receives core voltage input from an individual voltage regulator module (VRM). The VRMs regulate the system current and voltage according to the VID code output by the CPU package. The VRM is a DC-to-DC point of load convertor specified for +12 Volt input and programmable 100 Amp output.

Memory Architecture

Each CPU includes a low-latency, high-bandwidth, integrated DDR2 memory controller that reduces latencies during memory access over traditional front-side bus-based memory controllers. Up to four ECC Registered DDR2-667 memory modules per CPU are supported. The AMD Opteron processor's memory controller works in 64-bit (single channel) or 128-bit (dual channel) mode ECC operation. For best performance results, it is recommended to run 128-bit ECC operation mode. To run in 128-bit mode, DIMMs should be populated so that there is at least one DIMM in each 64-bit channel of each processor. The controller supports 1 bit per byte ECC, and supports DDR2-667 (PC2-5300) registered DDR SDRAM modules.

The Sun Fire X4100 M2 and X4200 M2 servers have 4 DDR2 DIMM slots per CPU that are color-coded white and black to indicate population order (white = 0,1 and black = 2,3; white pair first). LED fault indicators controlled by the ILOM Service Processor provide the ability to easily identify failed DIMM modules. Memory capacity scales with the number of processors. Therefore, memory attached to an unpopulated processor slot is unaddressable. As a result, a single processor machine can support a maximum of four DIMMs or 16 GB (4 x 4 GB) of memory. A dual CPU server supports a maximum of eight DIMMS or 32 GB (8 x 4 GB) of memory.

Other features of the Sun Fire X4100 M2 and X4200 M2 servers memory architecture include:

- Dedicated on-die 128-bit wide DDR2 memory controller
- Memory bandwidth up to 10.7 GB/sec. @ DDR2-667
- Under 80 ns latency
- Registered ECC DDR2-667 (PC2-5300) supported
- 1 GB to 4 GB low profile (1.2 inch/3.05 cm) DIMM support
- Up to 16 GB per CPU in with 4 GB DIMMs in 4 DIMM slots per CPU
- Single supply (2.50 VDC)
- Standard SPD (VCC-SPD=3.3V)

Note: The 32-bit version of Red Hat Enterprise Linux 3.0 is not capable of using more than 4 GB of physical memory, even if more than 4 GB is installed. This is a limitation of the default kernel, not the hardware.

x64 Architecture

The x64 architecture is an x86-compatible architecture that enables simultaneous 32-and 64-bit computing. It enables end users to run their existing installed base of 32-bit applications and operating systems at peak performance, while providing a migration path that is 64-bit capable. It is designed to enable 64-bit computing while remaining compatible with the vast x86 software infrastructure. x64 architecture represents a new class of computing, enabling a single architecture across 32- and 64-bit environments.

The x64 Instruction Set Architecture (ISA) extends the existing x86 ISA and natively executes 32-bit code with no emulation mode to degrade performance. For 32-bit software that does not require immediate 64-bit implementations, x64 processor-based systems are designed to provide full application performance while continuing to improve with x64 platform performance enhancements.

Many applications encounter architectural barriers that prevent efficient performance scaling. The x64 ISA is designed to allow continued performance scaling for applications that demand multiprocessor scalability, larger addressable memory, better multimedia performance, or improvements in computational accuracy.

The x64 ISA has been designed for applications that:

- Need large memory addressing to handle datasets larger then 3 GB per process (financial and scientific modeling applications)
- Must manage a large number of concurrent users or application threads, such as large-scale, thin-client solutions, large databases, data warehouse applications for solutions in customer relationship management (CRM), supply chain management (SCM), enterprise resource planning (ERP), and digital rights management (DRM) systems
- Require real-time encryption and decryption for enhanced security, including e-commerce and protection of private or classified data
- Require mathematical precision and floating-point performance, including modeling, simulation, statistics and financial analysis, imaging/video/signal processing, physics, medical research, telecommunications, encryption, and compression
- Require large, high-power database performance, including decision support, searching and indexing, document and content management, and voice recognition
- Require x86 compatibility or the economies of scale of x86 as well as the large memory addressing capabilities of 64-bit

computing, including many high-performance computing (HPC) cluster applications
- Provide digital content creation capabilities such as computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-aided engineering (CAE), digital music production and video editing, and real-time media streaming solutions
- Require maximum performance for realistic and cinematic consumer experiences, including computer games, digital video, and real-time collaboration.

x64 processors are designed to maintain full compatibility with x86 while providing the architectural enhancements that provide world-class 64-bit performance. With the x64 ISA, relevant instructions and encodings have evolved to support 64-bits, increasing the resources available to hardware and software. Major enhancements over legacy x86 include:

- Sixteen 64-bit general-purpose integer registers that quadruple the general purpose register space available to applications and device drivers as compared to x86 systems
- Sixteen 128-bit XMM registers for enhanced multimedia performance to double the register space of any current SSE/SSE2 implementation
- Full 64-bit virtual address space with 40 bits of physical memory addressing that can support systems with up to 4 petabytes of physical memory—65535 times the amount of RAM supported by 32-bit x86 systems
- 64 -bit operating systems to provide full, transparent, and simultaneous 32-bit and 64-bit platform application multitasking

x64 processors include HyperTransport Technology and are designed for flexibility and scalability. HyperTransport Technology provides links-based multiprocessing, simplifying the design of multiprocessor workstations and servers. Compatibility with x86 makes the x64 computing platform the first 64-bit platform designed to be compatible with mainstream PC applications while offering world-class performance, making it suitable for solutions ranging from consumer client PCs to high-performance clusters. The combination of flexibility and scalability reconciles the broad range of capability and performance requirements IT professionals face today.

AMD Direct Connect Architecture

AMD Direct Connect Architecture helps eliminate the bottlenecks inherent in a front-side bus by directly connecting the processors, the memory controller, and the I/O to the CPU to enable overall system performance and efficiency. Directly connected CPUs provide more linear, symmetrical multiprocessing. A memory controller directly connected to a CPU optimizes memory performance. I/O directly connected to a CPU provides more balanced throughput and performance. Dual-core processors extend the benefits of the AMD Direct Connect Architecture by connecting two CPU cores to each other on one die to reduce latencies between those cores.

HyperTransport™ Technology

HyperTransport™ Technology is a high-speed, high-performance, point- to-point link for directly connecting integrated circuits. HyperTransport Technology also directly connects the I/O to the processors at a rate of 8 GB/sec. Aggregate bandwidth per link, enabling a peak bandwidth of 24 GB/sec. per processor. The AMD Opteron processor with HyperTransport Technology provides a scalable direct connection between processors, I/O subsystems, and other chipsets. HyperTransport technology helps reduce the number of buses in a system, which can reduce system bottlenecks and enable today's faster microprocessors to use system memory more efficiently in high-end multiprocessor systems.

Memory Interface

In traditional x86 Northbridge/Southbridge architectures, processors share a memory controller and are not directly connected to one another. Memory transactions must propogate through the Northbridge chip fabric. This presents a bottleneck at the front-side bus that greatly reduces productivity and performance potential. In a Direct Connect Architecture, each CPU has its own integrated memory controller, which allows for more linear, symmetrical multiprocessing and optimized memory performance. This direct connection to the memory controller significantly reduces the memory latency seen by the processor. Latency will continue to drop as the processor frequency scales.

Additionally, hardware and software memory pre-fetching mechanisms can further reduce the effective memory latency seen by the processor. This reduction in memory latency, coupled with the additional increase in memory bandwidth available directly to the processor (resulting from this platform architecture design optimization), is critical as it greatly enhances system performance across all application segments.

Chip-to-Chip Interconnect

Current interface schemes offer throughput performance on the order of 266 MB/sec. to 1 GB/sec. Although these rates may be sufficient for desktop platforms, workstation, server, and other future platforms require a more robust interface. The simultaneous integration of high-speed technologies (such as Gigabit Ethernet, PCI-E, and the InfiniBand Architecture) onto high-end platforms will quickly dwarf the bandwidth capabilities of existing interfaces. Direct Connect Architecture using HyperTransport Technology provides a high-speed, chip- to-chip interconnect that virtually eliminates the I/O performance bottleneck while providing ample performance headroom for future growth.

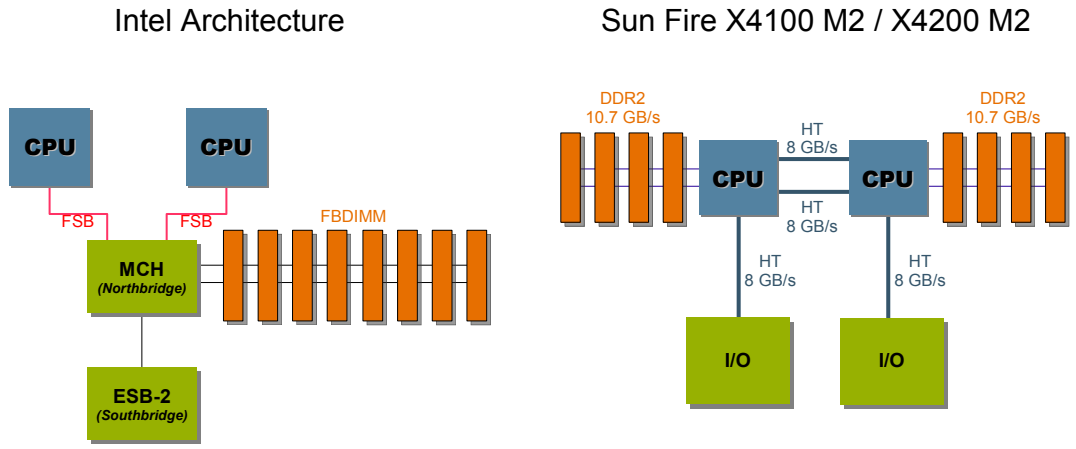


Figure 2-3: Intel vs. Opteron Architectures

I/O Expansion Capability to High-Speed Industry Buses

The traditional Northbridge/Southbridge architecture is not intended to support more than two core-logic elements. Adding additional high-speed functionality (such as Gigabit Ethernet, PCI-E, the InfiniBand Architecture, or any combination thereof) would have to occur in one of three ways:

- The functionality would have to be attached to an existing bus interface such as the PCI bus. However, an existing bus may not have sufficient bandwidth to support high-speed technologies, especially in instances in which multiple buses or combinations of buses must be supported simultaneously.
- The functionality would have to be directly attached to the higher speed proprietary chip-to-chip interconnect bus via a bridging device. However, the proprietary nature of this solution may limit the number of components available from vendors, thus impacting cost and availability.
- The functionality would have to be integrated into one of the core logic components. This solution is the least flexible, as a wide range of components would have to be created for each desired combination of feature-set buses.

HyperTransport Technology, an industry standard, provides system designers a high-speed, daisy-chained interconnect between system components. Specific components can be connected in a building-block fashion to achieve a platform with specific feature-set and performance objectives. Figure 2-4 shows a sample HyperTransport technology architecture block diagram.

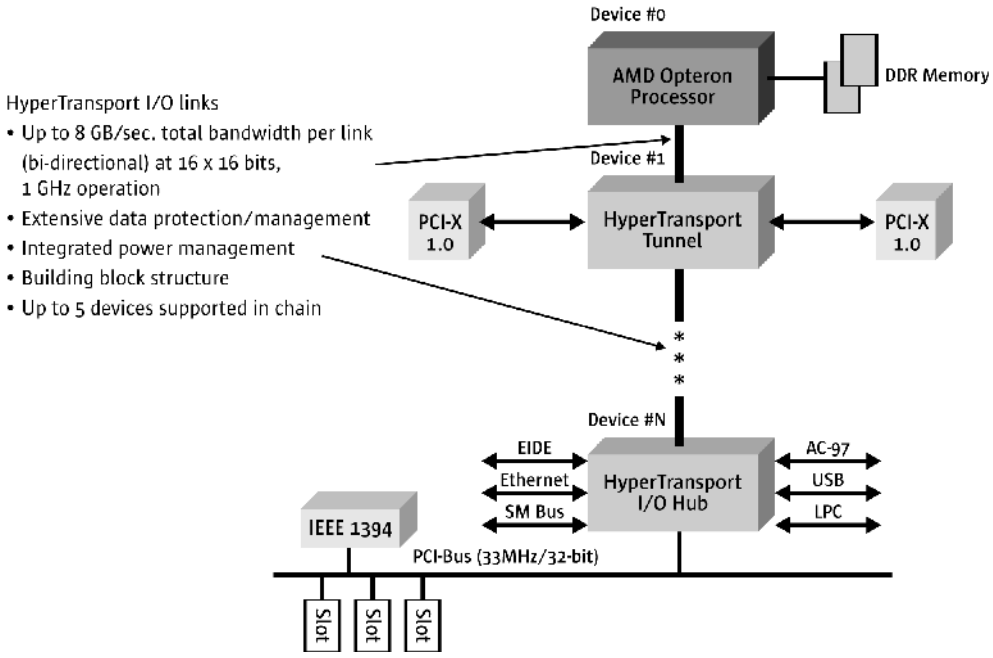


Figure 2-4: Sample HyperTransport Technology Architecture Block Diagram

Chapter 4

I/O Subsystem

Sun Fire X4100 M2 and X4200 M2 I/O Subsystem Overview

The Sun Fire X4100 M2 and X4200 M2 I/O subsystem is connected to the CPU complex through two HyperTransport links, one to each processor. The I/O subsystem consists of the following components:

- One NVIDIA nForce Professional 2200 (CK8-04)
- One tunneling HyperTransport bridges (AMD-8132 HyperTransport PCI-X Tunnel)
- One NVIDIA nForce Professional 2050 (IO-04)
- Flash memory for the BIOS
- Additional motherboard embedded peripheral I/O consisting of:
    - One quad channel SAS RAID controller (LSI SAS1064) attached to one of the AMD-8132 PCI-X Tunnels on a shared bus with the Intel dual Gigabit Ethernet controller
    - One 10/100/1000 dual Gigabit Ethernet MAC/PHY controller (Intel FW82546 GB NIC)
    - A video controller device attached to the PCI bus of the CK8-04 Southbridge (ATI Rage XL)
    - A Super I/O device connecting the Service Processor serial port to the CK8-04 Southbridge

Architecture Overview

The Sun Fire X4100 M2 and Sun Fire X4200 M2 servers feature up to 2 Next Generation AMD Opteron processors Series 2200, interconnected using two dedicated 8.0 GB/sec HyperTransport links, one of which is cache coherent. HT port 0 of CPU 0 connects to HT port 0 of CPU 1 and HT port 2 of CPU 0 connects to HT port 1 of CPU 1. Each processor controls 2 pairs of DDR2 DIMM slots, with 10.7 GB/sec access between processor and memory. Through HyperTransport, each processor has access to the other processor's memory. Dual CPU configurations of the Sun Fire X4100 M2 and X4200 M2 servers populated with 4 GB DIMMs provide up to 32 GB of memory. In single CPU systems, the processor must be placed into the designated processor slot 0. A HyperTransport Bridge must be inserted in socket 1 to ensure connectivity between CPU 0 and the rest of the I/O infrastructure. A single processor configuration has access to 2 pairs of memory slots or maximum of 16 GB using 4 GB DIMMs. DDR2/667MHz ECC registered memory components (a higher quality version of PC 5300 memory DIMMs) sold by Sun are supported.

The I/O architecture for the Sun Fire X4100 M2 and X4200 M2 servers is designed to provide balanced I/O, with high bandwidth connectivity to multiple devices. One NVIDIA nForce Pro 2200 and one NVIDIA nForce Pro 2050 chips provide four 8-lane PCI-Express expansion slots, one AMD 8132 provides 2 PCI-X segments for an on-board Serial Attached SCSI/ATA (SAS/SATA) interface for HDD control, one dual gigabit Ethernet controller as well as one PCI-X expansion slot.

NVIDIA nForce Professional 2000 Series Chipset

The NVIDIA nForce Pro 2000 series chipset implemented in the Sun Fire X4100 M2 / X4200 M2 servers consists of:

- 1 NVIDIA nForce Professional 2200 MCP
- 1 NVIDIA nForce Professional 2050 I/O companion chip

NVIDIA nForce Professional 2200 MCP (CK8-04)

The NVIDIA nForce Professional 2200 MCP, also known as CK8-04, features an 1 GHz HyperTransport link, flexible PCI Express interface, an enterprise-class native Gigabit Ethernet MAC, Serial ATA and ATA-133 support, USB2.0, PCI, and other standard peripheral functions.

The CK8-04 is connected to HT port 1 of CPU 0 via a 1 GHz 16x16 (8 GB/s) HyperTransport link. From this chip, 16 PCI-Express lanes are used to provide two 8-lane PCI-Express expansion slots, six USB 2.0 ports for the external USB ports and the ILOM RKVMS devices, one gigabit Ethernet port for external network connectivity, one ATA port for the DVD-ROM/CDRW player and one PCI port for the ATI Rage XL graphics controller.

NVIDIA nForce Professional 2050 I/O companion chip (IO-04)

NVIDIA nForce Professional 2050 I/O companion chip , also known as IO-04, features a 1 GHz HyperTransport link, flexible PCI Express interface, an enterprise-class native Gigabit Ethernet MAC, and Serial ATA.

The IO-04 connects to the AMD 8132 PCI-X Tunnel HT port 1 via a 1 GHz 16x16 (8 GB/s) HyperTransport link. From this chip, 16 PCI-Express lanes are used to provide two 8-lane PCI-Express expansion slots and one gigabit Ethernet port for external network connectivity. The two PCI-E expansion slots are populated in the Sun Fire X4200 M2 only.

AMD 8000 Series Chipset

The AMD 8000 series chipset implemented in the Sun Fire X4100 M2 / X4200 M2 servers consists of 1 AMD-8132 HyperTransport PCI-X Tunnel.

AMD-8132 HyperTransport PCI-X Tunnel

The AMD-8132 HyperTransport PCI-X Tunnel chip includes two 64-bit PCI-X bridges, bridge A and bridge B. Each independently supports conventional PCI mode with clock speeds of 33 and 66 MHz, or PCI-X mode with clock speeds of 66, 100, and 133 MHz. Each supports 64-bit addressing in PCI-X or PCI 2.2 and a 64-bit data bus. Each includes an IOAPIC register set for legacy interrupt modes. The upstream and downstream bi-directional HyperTransport tunnel links support receive and transmit frequencies of up to 1 GHz of 16-bits. These links also support independent transfer rates and bit width selection.

The AMD 8132 PCI-X Tunnel HT port 0 connects to HT port 2 of CPU 1 via a 1 GHz 16x16 (8 GB/s) HyperTransport link. From this chip, one 133 Mhz/64-bit PCI-X bus is used to provide a 133 Mhz/64-bit PCI-X expansion slot. This slot is populated in the Sun Fire X4200 M2 only. A second PCI-X bus, 100 Mhz/64-bit, is shared between the embedded LSI SAS disk controller and one Intel dual Gigabit Ethernet controller.

LSI SAS1064 SAS Controller

Sun Fire X4100 M2 and X4200 M2 servers include an integrated LSI SAS1064 4-port 3 Gbits/sec. SAS HW RAID disk controller. The LSI SAS1064 is a versatile controller that provides 4 SAS ports capable of 3.0 Gbits/sec. data transfers for each phys, for a total maxi-

mum bandwidth of 12.0 Gbits/sec.

SAS features of the LSI SAS1064 include:

- Four fully independent phys
- Support for 3.0 Gbits/sec. SAS data transfers for each phys
- High-performance, serial, point-to-point, enterprise-level storage interface
- Data transfers using SCSI information units
- 133 MHz 64-bit PCI-X interface (shared 100 MHz bus with Dual Gigabit Intel Ethernet controller)
- Integrated RAID solution provides Integrated Mirroring technology and Integrated Striping technology

Although the LSI SAS1064 controller is capable of supporting both SAS and SATA drive types, the Sun Fire X4100 M2 and X4200 M2 servers only support SAS hard disk drives.

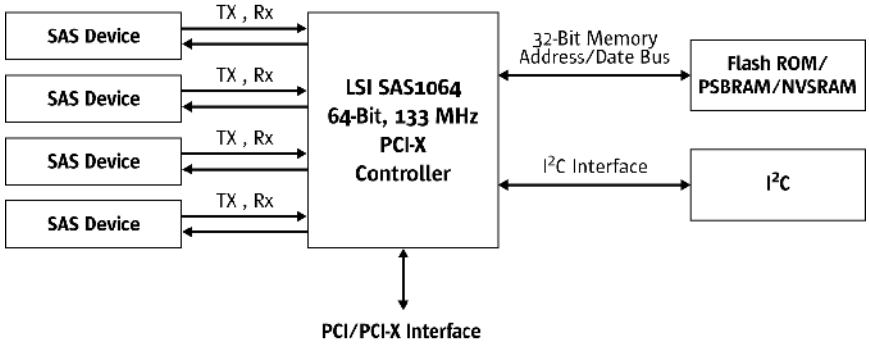


Figure 3-1: LSI SAS1064 Architecture Block Diagram

Intel 82546EB Dual Port Gigabit Ethernet Controllers

Sun Fire X4100 M2 and X4200 M2 servers are equipped with one Intel 82546EB Dual Port Gigabit Ethernet controllers that provide two Gigabit ethernet interfaces to the server platform. The Intel 82546EB Dual Port Gigabit Ethernet controller provides two 64-bit fully integrated Gigabit Ethernet Media Access Control (MAC) and physical layer (PHY) functions. It is capable of transmitting and receiving data at 10/100/1000 Mb/sec. data rate with half or full duplex capability. Additional features of the Intel 82546EB Dual Port Gigabit Ethernet controller include:

- 802.3ab PHY compliance and compatibility (CAT-5 use)
- 802.3ab auto-negotiation
- 802.3x full-duplex flow control
- 802.9q VLAN tag insertion, stripping, and packet filtering
- Preboot eXecution Environment (PXE) Flash Interface support (32- and 64-bit)

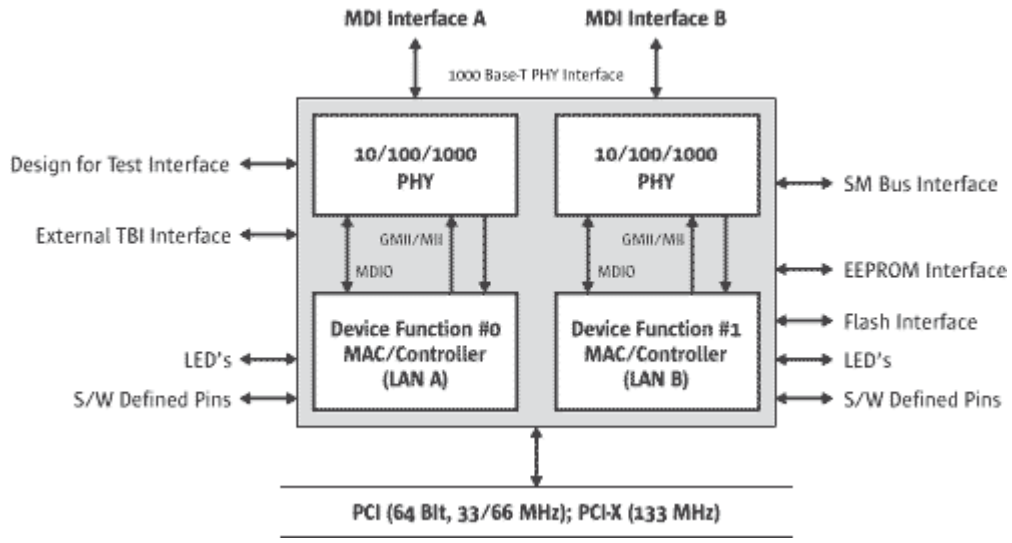


Figure 3-2: Intel 82546EB Dual Port Gigabit Ethernet Controller Architecture Block Diagram

ATI Rage™ XL Video

The Sun Fire X4100 M2 and X4200 M2 servers use the ATI Rage™ XL graphics controller to deliver 2D and 3D graphics acceleration. The DVI port is connected to the service processor for remote graphics redirection. The ATI Rage XL has the following features:
64-bit 125 MHz memory clock

- 8 MB external memory
- 64-bit SDR (SDRAM/SGRAM) memory path
- 64-bit AGP/PCI bus
- Integrated TMDS: DVI, DFP and VESA P&D interface
- Support for 24bit TTL
- 1600x1200 maximum resolution
- 16.7M maximum color depth
- 1024x768 TMDS

SMSC LPC47B272 Super I/O Controller

The Super I/O device offers multiple I/O functions required to provide legacy I/O devices to the operating environment. On the Sun Fire X4100 M2 and X4200 M2 servers, it provides the following:

- Floppy disk
- Serial port connection between SP and AMD-8111

PCI Expansion Slots

Sun Fire X4100 M2 Server PCI Expansion Slots

The Sun Fire X4100 M2 server features 2 PCI-E expansion slots. When viewing the server from the rear, PCI 0 is the lefthand slot and PCI 1 is the righthand slot. Both slots are Low Profile 8-lane PCI-Express expansion slots supporting up to 8-lane PCI-E expansion cards.

Sun Fire X4200 M2 Server PCI Expansion Slots

The Sun Fire X4200 M2 server offers 4 PCI-Express and 1 PCI-X expansion slots. When viewing the server from the rear, the PCI slots are present in numeric order from left to right and numbered from 0 to 4.

PCI0 and PCI1 are Low Profile 8-lane PCI-Express expansion slots supporting up to 8-lane PCI-E expansion cards. PCI2 is a 133MHz/64-bit MD2 PCI-X slot supporting both 33 and 66 MHz PCI expansion cards and 66, 100, and 133 MHz PCI-X expansion cards. PCI 3 and PCI 4 are both Low Profile 8-lane PCI-Express expansion slots supporting up to 8-lane PCI-E expansion cards.

The PCI-X slot on the Sun Fire X4200 M2 server use a 3.3 Volt signaling bus. Therefore, it only supports 3.3 Volt keyed MD2 expansion cards. The use of 5 Volt keyed expansion cards is unsupported and will result in damage to the motherboard. There are 2 defined card lengths for low profile PCI-X expansion cards, MD1 and MD2. MD1 defines the shortest 32-bit card length available, 4.721 inches (119.91 mm). MD2 defines the maximum length of low profile PCI card available, 6.600 inches (167.64 mm). Any low profile PCI card that is longer that the MD1 definition but shorter that the MD2 definition is considered to be MD2 form factor. The two card lengths enable system designers to support either all low profile PCI cards, which includes MD1 and MD2, or limit their design to support only MD1 cards.

Chapter 6

Cooling and Power

Typical heat dissipation and power consumption metrics for a Sun Fire X4100 M2 or X4200 M2 server equipped with 2 AMD Opteron Series 2200 processors, 4 GB RAM (4 x 1 GB), on 73 GB SAS HDD and 2 Power Supplies are as follows:

- Max Power Consumption: 351 W
- Heat Dissipation: 1198 BTU/hr
- Tons of Air Conditioning: 0.1

Note: Power consumption metrics can be calculated using the online Power Calculator for different configurations of the Sun Fire X4100 M2 (http://www.sun.com/x4100M2/) and Sun Fire X4200 M2 (http://www.sun.com/x4200M2/).

Cooling

The chassis of the Sun Fire X4100 M2 and X4200 M2 servers are segregated by an air divider into two distinct chambers: the motherboard/PCI and fan chamber and the Power Supply Unit (PSU) and storage chamber. Both areas are front-to-back air cooled. The PSU and storage chamber is cooled by individual fans on the back of each power supply. Air is drawn through the front of the server by these rear-located fans. The motherboard/PCI and fan chamber is cooled by redundant rows of fans mounted in front of the server behind the bezel.

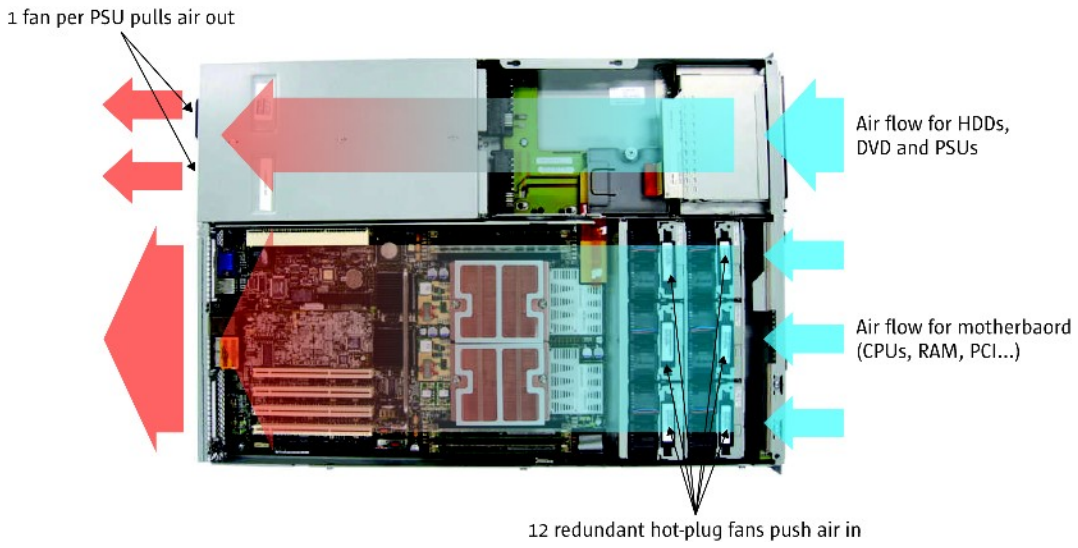

1 fan per PSU pulls air out
Air flow for HDDs,
DVD and PSUs
Air flow for motherbaord
(CPUs, RAM, PCI...)
12 redundant hot-plug fans push air in

Figure 5-1: Airflow Diagram of Sun Fire X4100 M2 and X4200 M2 Servers

Fans

Cooling fans in the Sun Fire X4100 M2 and X4200 M2 servers are positioned in two rows for redundancy just behind the front bezel. They are hot swappable and each fan module has an LED fault indicator. The fans are accessible from the top hinged hatch door in the front left side of the server, when facing the server from the front. This enables the fans to be accessed without interrupting system operation. Additionally, it makes it possible to service fans by only partially removing the server from the rack, allowing all cabling to remain in place.

Fan speed is modulated by the Service Processor with Pulse Width Modulation by an ADM 1026 sensor chip. All fans are controlled with the same PWM frequency so they all operate at the same speed. The ADM 1026 device uses readings from 3 sensors to control the fan speed: Front Panel Ambient Temperature, CPU 0 Die Temperature, CPU 1 Die Temperature. The Service Processor reads the fan speeds and turns the fan fault LED on if the RPM is under a threshold.

The fan modules in Sun Fire X4100 M2 and X4200 M2 differ from each other. The layout, however, is very similar in both servers. In the front of the motherboard compartment, beneath the hinged hatch door, there are 2 redundant rows of fan trays. Each row of fan trays is occupied by 3 fan modules. In a Sun Fire X4100 M2 server, the fan modules are populated by pairs of 40 mm, 15,000 RPM Delta TFB0412EHN fans. In a Sun Fire X4200 M2 server, the fan modules are populated by single 80 mm, 7,500 RPM Delta FFB0812UHE fans. The Sun Fire X4100 M2 server contains a total of 12 cooling fans and the Sun Fire X4200 M2 server contains a total of 6 cooling fans.

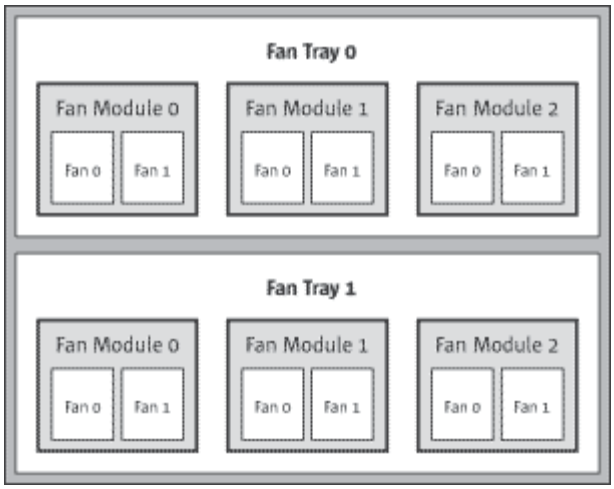


Figure 5-2: Sun Fire X4100 M2 Server Cooling Fan Layout

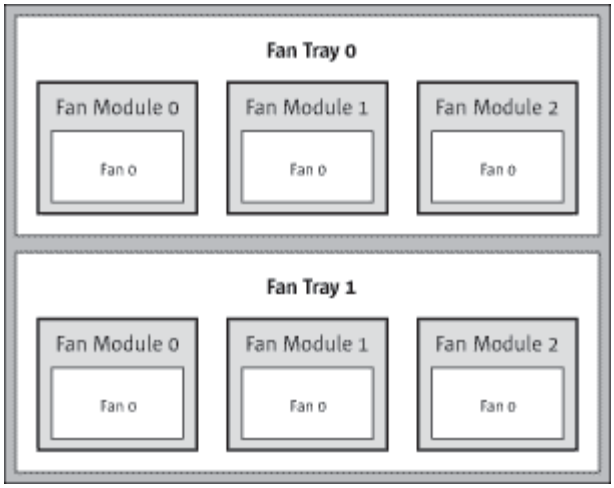


Figure 5-3: Sun Fire X4200 M2 Server Cooling Fan Layout

Power Supplies

Sun Fire X4100 M2 and X4200 M2 servers are powered by dual redundant hot-swappable power supplies.

The power supplies have the following features:

- 550 Watts
- 120/240 Volt – 50/60 Hz Autodetect
- 1 40 mm fan in rear
- Power sharing

Chapter 7
ILOM: Integrated Lights Out Management

Integrated Lights Out Management (ILOM) is the Service Processor. ILOM enables multiple in-band and out-of-band management solutions. In-band management through the host operating system, or platform, is enabled by IPMI and SNMP OS-resident agents. Out-of-band management is enabled through the serial port or dedicated Ethernet. There is a command line interface (CLI) provided when out-of-band serial port conenctivity is used. The dedicated Ethernet connectivity to out-of-band management features includes:

- Web interface
- CLI via SSH
- IPMI 2.0
- SNMP v1, v2c, and v3

ILOM Architecture

The Sun Fire X4100 M2 and X4200 M2 servers leverage the same ILOM design and part. ILOM is a Sun-designed Field Replaceable Unit (FRU) daughtercard. The ILOM daughtercard has the following features:

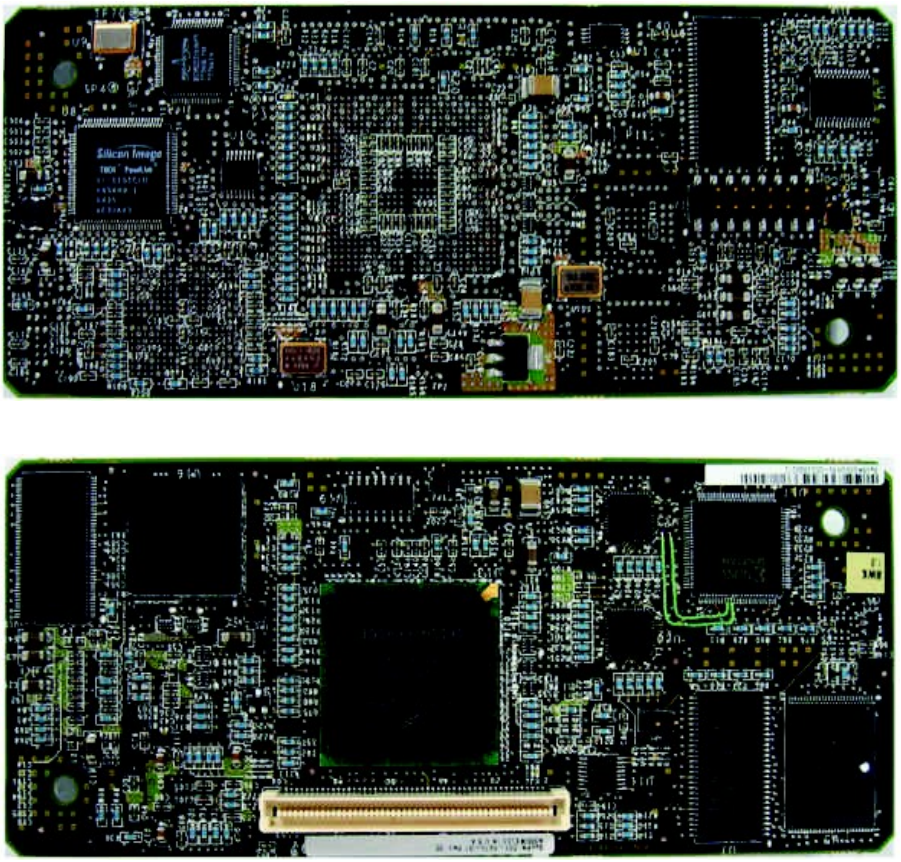
- Motorola MPC8248 PowerPC processor
- 32-bit 266 MHz
- 16 Kb 4-way associative data cache
- 16 Kb 4-way associative instruction cache
- 64-bit data bus
- 66 MHz PCI bridge
- 64 MB PC-133 MHz SDRAM
- 16-bit 32 MB Flash ROM
- DVI output
- USB connections to AMD-8111 I/O Hub
- LPC (Low Pin Count) connection to AMD-8111 I/O Hub
- 10/100 Mb Integrated LAN
- 3 serial ports (Debug, RS485, external)
- Half-size standard PCI form factor

The ILOM daughtercard is a standalone system with no dependencies on the operating system. It has availability to physical interfaces through the connections listed above. The actual devices, however, are located on the main system board. The DVI output port is connected to the ATI Rage XL via FPGA to enable remote graphics redirection from ILOM with a maximum VGA resolution of 1024 x 768. Three USB connections to the AMD-8111 I/O Hub are used to provide remote keyboard, mouse, and storage functionality. There is an LPC connection to the AMD-8111 I/O Hub via FPGA. The 10/100 Mb Ethernet is connected to the onboard Broadcom BCM5221 10/100 Ethernet controller which automatically

detects straight or cross-over Ethernet cables. The external serial port is multiplexed with the main system serial port for access to

the ILOM CLI and system console using serial port redirection (S-o-L Serial-over-LAN).

Figure 6-1: ILOM Daughtercard — Top and Bottom Views



ILOM Software

ILOM is an IPMI 2.0-compliant Baseboard Management Controller (BMC) which implements Lights Out Management (LOM) including "Remote Keyboard, Video, Mouse, and Storage" (KVMS), a Web management interface, a command line interface (CLI) and SNMP. ILOM software includes the following:

- Embedded, hardened Linux OS
- IPMI 2.0 BMC
- Platform Control agents diagnostics software
- RKVMS

The ILOM and BIOS firmware are easily upgraded using a single 11 Mb file to upgrade both. The firmware upgrade can be performed either by command line interface or Web interface.

In-Band Server Management Interfaces

Server management through the platform operating system in a Sun Fire X4100 M2 or X4200 M2 server is possible using either IPMI with a Keyboard Controller Style (KCS) inteface and an IPMI kernel driver or by using SNMP OS-resident agents. IPMI 2.0 and SNMP v1, v2c, and v3 are the supported standards to perform autonomous platform management functions.

Baseboard Management Controller (BMC)

ILOM and its controlling firmware are together referred to as the Base Management Controller (BMC), which is the core of the IPMI structure. Tightly integrating an IPMI BMC and management software with platform firmware facilitates a total management solution.

Out-of-Band Server Management Interfaces

Server management through the ILOM service processor in a Sun Fire X4100 M2 or X4200 M2 server is possible through serial port access or dedicated Ethernet connection. Serial port connectivity to ILOM provides direct console access to the command line interface (CLI)and to the system console stream via serial port redirection, i.e., serial-over-LAN. The dedicated Ethernet interface offers ILOM connectivity by Web interface, CLI via SSH, IPMI 2.0, and SNMP v1, v2c, and v3.

Command Line Interface (CLI)

The ILOM command line interface is accessible either by connection to the serial port or the dedicated Ethernet connection via Secure Shell (SSH) on a Sun Fire X4100 M2 or X4200 M2 server. The CLI is designed to follow the Distributed Management Task Force (DMTF) Command Line Protocol (CLP).

The DMTF CLP is based on these concepts:

- Object namespace—There is a large namespace of objects to describe the targets for each command. Examples of objects are a CLI user, an SNMP trap, or an alert rule.

- Command verbs—There are a small number of command verbs that operate on those objects. Command verbs are simple and include create, delete, set, show, start, and stop, for example.
- Object properties—An object may have one or more properties, or parameters. For example, a user ID object has a password and roles properties.
- Options—A command may have options that modify or clarify its operation. The DMTF CLP lists several options that must be supported by all commands.

The syntax of an ILOM command is

```
<verb> <options> <target> <properties>
```

Not all commands require options, a target, or properties to be specified.

The core of the model for the DMTF CLP is a hierarchical objects namespace where an object in the namespace is a target to a command. There are two namespaces that an SP can reference: its own namespace whose root is /SP, and the overall system namespace whose root is /SYS. The purpose of the /SP namespace is to represent configuration and state for the SP. The primary purpose of the /SYS namespace, for the SP, is to allow access to sensors and other information about system hardware by the SP.

Web Interface

The Web interface to the Sun Fire X4100 M2 and X4200 M2 ILOM Web interface supports both secure (https) and non-secure (http) access. Secure access will be enabled by default. The Web interface provides the same functionality as the CLI. It is divided into five main sections:

- System Information
- System Monitoring
- Configuration
- Remote Controller
- Maintenance

Remote Keyboard, Video, Mouse, and Storage (RKVMS)

Remote Keyboard, Video, Mouse, and Storage (RKVMS) features are accessible through the ILOM Web interface.

Remote video display is accomplished through the JavaRConsole which is a Java™ Web Start application. JavaRConsole is downloaded from ILOM to the management console machine and executed locally. It does not run on the server and therefore does not put overhead on the host. JavaRConsole is used to redirect the BIOS and setup screens as well as all other platform video output. It provides a true remote video console to the management console by handling the input and output to and from virtual devices and the Sun Fire server. 8- and 16-bit video display are supported up to 1024 x 768. JavaRConsole requires the installation of Java Runtime Environment 5.0 on the management console.

The 3 USB ports connected between the ILOM service processor and the AMD-8111 I/O Hub enable the remote keyboard, mouse, and

storage components of the RKVMS functionality. The remote devices are presented to the Sun Fire server by JavaRConsole and ILOM as virtualized local devices.

JavaRConsole captures keyboard and mouse input on the management console and directs it to ILOM. ILOM then transmits these keyboard and mouse inputs over the USB ports to the AMD-8111 aI/O Hub and to the Sun Fire server. The Sun Fire server interprets these inputs as originating from local USB devices.

JavaRConsole is also capable of presenting remote bootable storage to ILOM and the Sun Fire server. The remote storage can be either physical storage devices or bootable media image files on the hard drive. Several types of remote storage are supported:

- CD/DVD-ROM
- Floppy
- CD/DVD-ROM image (.iso files)
- Floppy image (.img files)

When the Sun Fire X4100 M2 or X4200 M2 server attempts to access a Virtual Floppy or Virtual CD-ROM as set up in the BIOS, ILOM redirects this access request to the JavaRConsole. JavaRConsole then accesses the virtual disk content from the management console's physical CD/DVD-ROM drive, physical floppy drive, or from a disk image on the hard drive. ILOM virtualizes this remote storage to the Sun Fire server using the USB ports connected to the AMD-8111 I/O Hub. The Virtualized storage is recognized by the Sun Fire server as local USB connected storage and enables remote operating system boot up and installation.

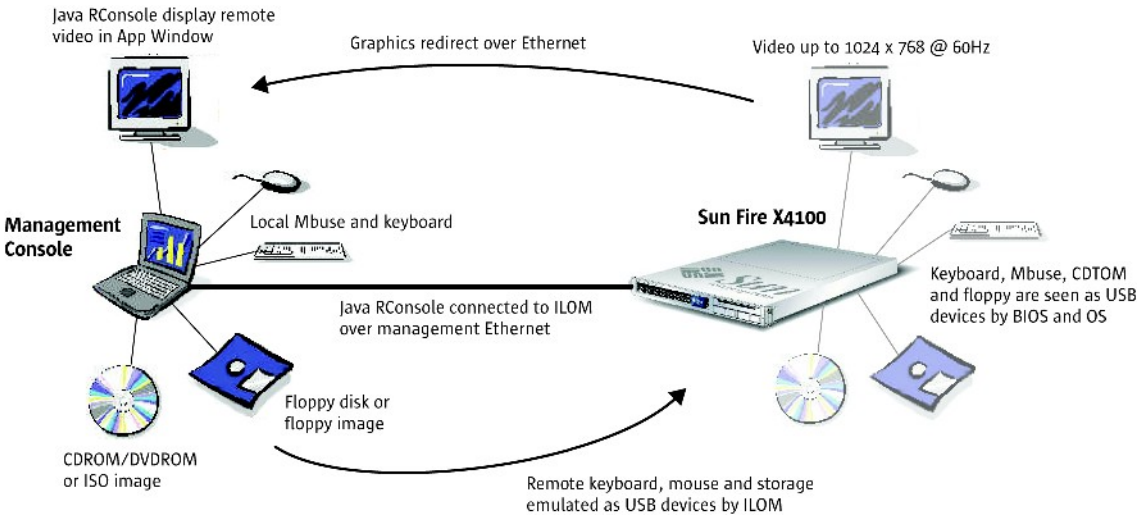

Java RConsole display remote video in App Window
Graphics redirect over Ethernet
Video up to 1024 x 768 @ 60Hz
Management Console
Local Mbuse and keyboard
Sun Fire X4100
Keyboard, Mbuse, CDTOM and floppy are seen as USB devices by BIOS and OS
Java RConsole connected to ILOM over management Ethernet
Floppy disk or floppy image
CDROM/DVDROM or ISO image
Remote keyboard, mouse and storage emulated as USB devices by ILOM

Figure 6-2: Illustration of RKVMS Functionality

Lights Out Management (LOM)

Lights Out Management is performed on the Sun Fire X4100 M2 and X4200 M2 servers through IPMItool, a command-line utility for controlling IPMI-enabled devices.

Intelligent Platform Management Interface (IPMI)

Platform management refers to the autonomous monitoring, logging, recovery, and inventory control features implemented in hardware and firmware. The key differentiator of Intelligent Platform Management is that these functions are independent of the main CPU, BIOS, and OS. There are two major components of platform management: the Service Processor (or BMC) and System Management Software (SMS). Intelligent Platform Management capabilities are a key component in providing enterprise-class management for high-availability systems. Platform status information can be obtained and recovery actions initiated under situations where system management software and normal in-band management mechanisms are unavailable.

The Service Processor is the brain behind platform management and its primary purpose is to provide autonomous sensor monitoring and event logging features. Typical sensor-related events are out-of-range temperature or voltage and fan failure. When an event occurs, it is noted in the system event log and made available to SMS. The Service Processor is powered by the power supply standby voltage and will function even when the server is powered down or the operating system has crashed. This allows platform status to be obtained and recovery initiated under situations in which in-band delivery mechanisms are unavailable. In modern systems, the Intelligent Platform Management Interface provides a hardware-level interface specification for monitoring and control functions. It defines a standard, abstract, message-based interface between the BMC and SMS and a common set of commands for operations such as accessing sensor values, setting thresholds, logging events, and controlling a watchdog timer. IPMI messages can be

used to communicate with the BMC over serial and LAN interfaces, so software designed for in-band (local) management can be re-used for out-of-band (remote) management simply by changing the low-level communications layer.

IPMItool

IPMItool is a simple command-line interface to systems that support the IPMI v2.0 specification. IPMItool provides the ability to read the sensor data repository and print sensor values, display the contents of the system event log, print field-replaceable unit information, read and set LAN configuration parameters, and perform remote chassis power control. IPMItool was originally written to take advantage of IPMI-over-LAN interfaces but is also capable of using the system interface as provided by a Linux kernel device driver such as OpenIPMI or a Solaris™ driver called BMC, which is included in Solaris 10. IPMItool is available under a BSD-compatible license. System Management Software is generally complex and makes platform management only part of a much larger management picture. However, many system administrators and developers rely on command-line tools that can be scripted and systems that can be micro-managed. IPMItool takes a different approach to SMS and provides a completely command-line oriented tool. Therefore, it is not designed to replace the OpenIPMI library. Where possible, IPMItool supports printing comma-separated values for output to facilitate parsing by other scripts or programs. It is designed to run quick command-response functions that can be as simple as turning the system on or off or as complex as reading in the sensor data records and extracting and printing detailed sensor information for each record.

SNMP

SNMP management provides remote access by SNMP-compliant entities to monitor and control network devices, and to manage configurations, statistics collection, performance, and security on a network. SNMP is a network management protocol used almost exclusively in TCP/IP networks. The Sun Fire X4100 M2 and X4200 M2 servers provide SNMP MIBs to manage and monitor the servers using any SNMP-capable network management system, such as HP OpenView Network Node Manager (NNM), Tivoli, CA Unicenter, or IBM Director. The MIB data describes the information being managed, reflects current and recent server status, and provides server statistics.

SNMP v1, v2c, and v3 will be supported. v1 and v2c will be disabled by default. v3 will be enabled by default. SNMP sets may be enabled and disabled and will be disabled by default. SNMP traps can be generated from within the SP. An IPMI-specific trap, called a Platform Event Trap, or PET, may also be generated. The following SNMP MIBs are supported:

- The system group and SNMP group from the RFC1213 MIB
- SNMP-FRAMEWORK-MIB
- SNMP-USER-BASED-SM-MIB
- SNMP-MPD-MIB
- ENTITY-MIB
- SUN-PLATFORM-MIB

Sun N1 System Manager

As the number of systems grow in any organization, the complexities of managing this infrastructure through its

lifecycle becomes increasingly apparent. A server could see many re-provisions applied to it in its lifetime. Once provisioned, organizations must continuously monitor and manage the infrastructure to ensure that systems are running at desired levels.

Managing each step of the infrastructure lifecycle is challenging for even the most sophisticated IT organizations. Sun N1™ System Manager helps customers address these problems with its new infrastructure lifecycle management software.

Designed specifically to address the problems associated with managing infrastructure throughout its lifecycle, N1 System Manager helps customers provision, monitor, and manage Sun x64 servers. N1 System Manager will expand in breadth of HW coverage over time to encompass current and future Sun systems.

Sun N1 System Manager enables the provisioning, monitoring, patching and management of hundreds of Sun's AMD Opteron based x64 servers. Management tasks are executed through a hybrid UI that integrates the GUI and CLI in one console. The ability to create logical groups of systems and perform actions across a group of systems as easily as performing actions on a single system is possible with N1 System Manager. Additionally, a central console is provided to rapidly deploy Solaris or Red Hat Linux to multiple Sun x64 servers.

The key features of the Sun N1 System Manager software are:

- Bare metal discovery
- Grouping
- Bare metal provisioning
- Hardware monitoring
- OS provisioning

Chapter 8

Software Operating Environment

The Sun Fire X4100 M2 and X4200 M2 servers support multiple 32-bit and 64-bit operating systems, including Solaris, Linux, and Windows. The Sun Fire X4100 M2 and X4200 M2 servers are also VMware ESX Server compatibility certified. Table 7-1 lists the different operating systems supported on the Sun Fire X4100 M2 and X4200 M2 servers.

Table 7-1: Supported Operating Systems

Operating System		Sun Supported
Solaris 10 on x64	64-bit	Yes
Red Hat Enterprise Linux 3.0	64-bit	Q1CY2007
Red Hat Enterprise Linux 4.0	64-bit	Yes
SuSE Linux Enterprise Server 9	64-bit	Q1CY2007
Microsoft Windows Server 2003	32-bit	Yes
Microsoft Windows Server 2003	64-bit	Yes
VMware ESX Server 3.0.1	32-bit	Yes

Solaris 10 on x64, Red Hat Enterprise Linux, SuSE Linux Enterprise Server, and VMware ESX Server operating systems can be ordered from Sun. Support contracts are also available for these operating systems as well as Microsoft Windows Server 2003 Enterprise/Advanced Server Editions 32/64-bit from Sun for the Sun Fire X4100 M2 and X4200 M2 servers.

The Sun Fire X4100 M2 and X4200 M2 servers have been qualified by Vmware and are listed on the VMware Hardware Compatibility List which can be seen by visiting the following VMware Web site:
http://www.vmware.com/pdf/esx_systems_guide.pdf

Factory Pre-Installed image

- Solaris 10 64-bit 6/06 (U2)
- Java Enterprise System, Release 4 2005Q4
- Sun Studio 11
- nge patch 122530-02
- 100MB free disk space for LSI RAID metadata

Solaris Operating System Features

Solaris 10 delivers performance advantages for database, Web, and Java technology-based services, as well as massive scalability with price/performance advantages.

- Real-time troubleshooting of system problems
- New tools for low-level system debugging
- System hardware testing and analysis
- Fine-grained project accounting

- Enhanced patch analysis and delivery tools
- Existing applications benefit from Solaris 10 enhancements without modification
- Provides integrated Sun Java™ Enterprise System suite components and the Sun Java Desktop System
- Includes 187 of the most popular free and open source software packages, many of which are supported by Sun
- Provides integrated developer tools such as GNU utilities and Perl and Python programming languages

NOTE: All occurrences of Solaris 10 OS for the Sun Fire X4100 M2 and X4200 M2 servers refer specifically to Solaris 10 for x64 OS, which is the minimum required Solaris release for the Sun Fire X4100 M2 and X4200 M2 servers.

Key Productivity Features

The Solaris Operating System delivers several critical performance and reliability features, such as:

- Enhanced ease of use and PC-interoperability features
- Integrated, high-performance Java technology and tools
- Robust software developer environment
- Advanced, standards-based networking
- Improved systems installation and management tools
- Enterprise-class directory services
- Enhanced desktop tools, I/O standards, and security

Other key features include:

- 100% binary compatibility
- Reliability, availability, and serviceability
- Java 2 SDK
- IPv6/IPsec/Mobile IP
- LDAP directory services
- System management tools
- Desktop management and productivity tools
- Observability
- Internationalization
- Data management
- Real-time application support
- Enhanced security features

Manageability Features

The Solaris 10 Operating System dramatically improves the way system administrators and developers can identify the reasons for suboptimal system and application performance. Solaris Dynamic Tracing (DTrace) technology makes it possible to delve deeply into today's complex systems to troubleshoot problems in real time and quickly eliminate bottlenecks. Additional Solaris 10 features provide enhanced system insight, enabling a system administrator to quickly

identify and resolve hardware problems, and streamline and automate patch management. Solaris Containers can also consolidate multiple applications onto a single system to increase utilization rates and cut system and licensing costs.

Existing applications that adhere to the Solaris x64 OS application binary interface (ABI) and that are compiled with the same APIs, will run unmodified on x64 platforms. In addition, Sun provides an easy-to-use AppCert testing tool for developers to verify existing Solaris OS application binaries and report any potential incompatibilities.

Interoperability

Understanding that businesses today rely on a mix of technologies from a variety of vendors, Solaris 10 provides tools to enable seamless interoperability with hundreds of heterogeneous hardware and software platforms.

Availability

New Solaris 10 features, such as Predictive Self Healing, offer capabilities that automatically diagnose and recover from hardware and application faults, maximizing system uptime.

Advanced Networking

Support for IPv6 in the Solaris OS is integrated into NFS, RPC, NIS, NIS+, and DNS. IPsec enables secure virtual private networks and network access control. Mobile IP provides Internet disconnect/reconnect capabilities with no data loss.

Bundled Software

Software bundled with the Solaris OS includes Oracle 8i Enterprise Edition, lxrun for Linux application compatibility (for the Solaris OS x64), Apache Web Server, Netscape Communicator, Sun Java System Directory Server, gzip, bash, and tcsh.

The Solaris operating environment ships with a number of software components that increase overall availability, including Solaris Resource Manager software for fine-grained control of system resources, Solaris Bandwidth Manager software for enhanced network resource availability, and Sun Cluster 3.1 software for even greater application availability through a clustered file system, scalable data services, and built-in load balancing.

Sun Studio (90-Day Trial Version)

Sun Studio 10 software is Sun's latest and best developer tool suite for C, C++ and Fortran application development. It continues to provide corporate developers and ISVs with a comprehensive, integrated suite of tools for the development, debugging, tuning, and deployment of enterprise applications on Sun platforms. With this release, Sun Studio 10 software extends its world-class development environment to the AMD64 architecture and delivers reliable, scalable, and high-performance applications for the Solaris 10 Operating System.

Additionally, Sun Studio 10 software provides a common debugger that can visually debug single and multi-threaded C, C++, and Fortran code. It can even handle intermixed Java and native code, an industry first! All of these powerful tools are presented within a

NetBeans™-based Integrated Development Environment.

Sun Studio 10 software also provides an integrated development environment (IDE), performance analysis tools and intuitive debugger for Linux operating systems. These components are compatible with GCC 3.2 software. Note that Sun is not supplying or providing support for the gcc compiler.

Customers using prior software versions including Forte Developer 6 Update 2, Sun ONE Studio 7 Enterprise Edition, Sun Studio 8, and Sun Studio 9 releases can easily upgrade to Sun Studio 10 software since it is fully compatible with these previous releases. The software is full of productivity enhancements, feature improvements, and expanded platform support to make Solaris and Linux application development more productive.

Solaris Flash Software

To improve utilization of the systems that make up today's data centers, administrators are turning to tools such as Solaris Flash software. Solaris Flash software provides new provisioning functionality that allows administrators to capture a snapshot image of a complete system—including the Solaris OS, the applications stack, and the system configuration into a new Flash Archive format. Using this system image, administrators can then rapidly replicate a reference system configuration onto many target systems. Solaris Flash images can be deployed via standard media or over the network via HTTP and NFS protocols. Solaris Flash software images can be installed using custom Solaris JumpStartTM software scripts, the Solaris Web Start software graphical interface, or through interactive installation of the Solaris Operating System.

Solaris LIVE! Upgrade Software

Solaris LIVE!TM Upgrade software allows Solaris OS software to be installed on a separate partition from the currently running version of the operating environment. In particular, Solaris LIVE! Upgrade software enables systems to run uninterrupted while a system administrator installs a Solaris Flash archive or upgrades to a new version of the Solaris Operating System. As a result, downtime for upgrades is reduced to the time needed for a reboot. When installation is complete, a simple reboot enables the Solaris 10 OS to take control. Since Solaris LIVE! Upgrade software includes a version migration and fallback feature, organizations can also fall back to the previous release (again, through a simple reboot) without losing administration information.

Real-Time Video Creation and Broadcast Support

A Java Media Framework (JMF) technology player provides access to the latest industry-standard audio and video files, including MPEG1/2, QuickTime, VIVO, AVI, AIFF, GSM, WAV, RMF, AU, and MIDI.

Solaris 10 OS Bundled Desktop Environments

Common Desktop Environment (CDE) Enhancements

The latest generation of the Common Desktop Environment (CDE) comes standard, providing workstation users with an easy-to-use, open, secure platform. Personal Digital Assistant (PDA) support synchronizes data from most Palm computing devices with the CDE

calendar, mail, memo, and address book. CDE now features streaming video using MPEG1, MPEG2, QuickTime, and AVI formats, as well as MIDI audio using Java Media Framework technology.

GNOME 2.0 Desktop Environment

GNOME 2.0, the modern desktop for the Solaris 10 Operating System (OS), provides applications and tools that are designed to enhance business productivity in a networked world. GNOME 2.0 helps organizations achieve their business goals by offering a unified, modern, open, networked, and cost-effective desktop solution. Key features of GNOME 2.0 include:

- Personalization capabilities that allow users to change settings to suit their preferences
- Removes complexity of supporting disparate desktop user environments and provides a richer common unified desktop
- Open file standards provide transparent file and data interchange
- Built-in accessibility support enables all users to interact with the GNOME 2.0 desktop environment running on any UNIX platform
- Flexibility and choice to run GNOME, CDE/Motif, and Java technology-based applications unmodified, preserving existing software investments
- Support for key open standards to facilitate interoperability, compatibility, and collaboration in today's highly-networked, heterogeneous world, including support for XML, DOM, HTTP, HTML, CORBA, MIME, Unicode, MPEG, JPEG, AVI, MIDI, XDnD (drag & drop), X11, NFS, and TCP/IP

GNOME 2.0 for the Solaris OS is open source, free software with no upgrade or licensing fees. More information about GNOME 2.0 is available at http://www.sun.com/gnome.

Solaris OS Licensing and Usage

Under the Free Solaris™ Binary License Program, Sun is making the binary (runtime) version of its Solaris 10 OS available to anyone who accepts the terms of the Solaris OS Binary Code License (BCL) and the Free Solaris Binary License Program. There are no fees for the right to use the software on computers with a capacity of eight or fewer processors. There is a small charge for the media kit. Refer to http://www.sun.com/software/solaris for current licensing details.

Features of the Solaris OS license include the following:

- No distinction between desktop and server licenses
- Free binary (runtime) license for all systems with eight or fewer CPUs for users who accept the terms of the Solaris 10 OS Binary Code License and the Free Solaris Binary License Program
- Solaris 10 OS software is provided via the Solaris 10 Media Kit available for purchase at http://www.sun.com/solaris/binaries
- Single Solaris Media Kit for installing multiple systems
- Solaris Media Kit contains additional bundled software
- Solaris Supplemental CD of bundled user and system management tools
- Oracle 8i Enterprise Edition (with development license)
- StarOffice™ 7.0 productivity suite
- Solaris Software Companion CD of popular freeware

Chapter 9
Additional Software Included

Sun Installation Assistant

The Sun Installation Assistant software on CD-ROM is included in the ship-kit with every Sun Fire X4100 M2 and X4200 M2 server. Sun Installation Assistant is a Linux installation utility that reduces the complexity of installing supported Linux distributions on new hardware. A newly released platform seldom has a certified set of drivers already in a current Linux distribution. Typically, the result is that an administrator will be required to generate driver disks for each of the supported Linux distributions that they plan to install. Additionally, Linux distributions do not contain support for
non-platform drivers such as the Service Processor.

A complete Linux installation on a Sun Fire X4100 M2 or X4200 M2 server can be easily performed using the Sun Installation Assistant CD-ROM either locally or remotely using the remote KVMS features provided by ILOM and the JavaRConsole.

Once the system has been booted from the media or image, a boot kernel is loaded and probes the platform configuration. Upon recognition that the server is a supported platform, a list of the currently supported Linux distributions is displayed and the user is prompted to insert disk 1 of the supported Linux distribution of their choice. Disk 1 can be either a physical CD-ROM disk or a JavaRConsole redirected iso disk image. The Linux distribution installation continues as usual until completion. Following installation completion, the certified platform and device drivers are installed and the complete installation is completed without necessitating cumbersome driver installation procedures. The Sun Installation Assistant manages the software installation of:

- Supported Linux operating systems
- Platform-specific software
- Diagnostic and fault management software
- Add-on components such as the JES middleware stack

Appendix A

Sun Fire X4100 M2 and X4200 M2 Rack Mounting Specifications

Sun Fire X4100 M2 and X4200 M2 servers should fit in nearly all 3rd-party racks which meet these criteria:

- Rack has a horizontal opening with unit vertical pitch conforming to ANSI/EIA 310-D-1992 and/or IEC 60927
- Four-post structure (i.e. mounting at both front and rear)
- Distance between front and rear mounting planes is between 610 mm and 915 mm (24 to 36 inches)
- Clearance depth (to front cabinet door) in front of front rack mounting plane is at least 25.4 mm (1 inch)
- Clearance depth (to rear cabinet door) behind front rack mounting plane is at least equal to the cable management arm
- Clearance width (between structural supports, cable troughs, etc.) between front and rear mounting planes is at least 456 mm (18 inches)

To permit installation in racks meeting the above criteria, there is only one rackslide and cable management arm set for the Sun Fire X4100 M2 and X4200 M2 servers. There is no provision in the slide brackets for mounting to non-standard side planes within rack cabinets all mounting is to front and rear planes only.

For reference, most generic 19-inch format racks of 900 mm or greater overall depth can accommodate the Sun Fire X4100 M2 and X4200 M2; the systems will fit in some shallower racks, and many at 800 mm without the cable management arm.

Appendix B

Sun Fire X4100 M2 and X4200 M2 Server Dimensions

The Sun Fire X4100 M2 and X4200 M2 servers have the following size and weight dimensions.

Table B-1: Sun Fire X4100 M2 and X4200 M2 Server Dimensions

	Sun Fire X4100 M2	**Sun Fire X4200 M2**
Weight	41.1 lbs / 18.6 Kg maximum w/rack kit	56.2 lbs / 25.5 Kg maximum w/rack kit
Height	1.72 in / 43.8 mm	3.44 in / 87.6 mm
Width	17.5 in / 445 mm	17.5 in / 445 mm
Depth	24.8 in / 632 mm	24.8 in / 632 mm

Appendix C

Environmental and Regulatory Compliance

The Sun Fire X4100 M2 and X4200 M2 servers meet or exceed the following environmental and regulatory specifications.

Table C-1: Sun Fire X4100 M2 and X4200 M2 Servers Environmental Specifications

Type	Specification
Operating temperature (single, non-rack system)	10º C to 35º C (41º F to 95º F), 10% to 90% relative humidity, non-condensing, 27º C max wet bulb
Non-operating temperature (single, non-rack system)	-40º C to 65º C (-40º F to 149º F), up to 93% relative humidity, non-condensing, 38º C max wet bulb
Operating altitude (single, non-rack system)	35º C up to 900 meters and a derating of 1 ºC for every 300 m in altitude up to 3048 m maximum
Non-operating altitude (single, non-rack system)	Up to 12000 meters
Acoustic noise (single, non-rack system)	Less than 69 dB sound power in ambient temperature of up to 24º C

Table C-2: Sun Fire X4100 M2 and X4200 M2 Servers Regulatory Specifications

Type	Specification
Safety	IEC60950, UL/CSA60950-01, EN60950, CB Scheme with all country differences
RFI/EMI	FCC Class A, Part 15 47 CFR, EN55022, CISPR 22, EN 300- 386:v1.3.1, ICES-003
Immunity	EN55024, EN 300-386:v1.3.2
Related Certifications: Safety	cULus Mark, TUV GS Mark, CE Mark, CCC, BSMI, GOST R, S-Mark
Related Certifications: EMC	CE Mark (93/68/EEC) Emissions and Immunity, Class A Emissions Levels: FCC, VCCI, BSMI, C-Tick, MIC, GOST, CCC
Other	Labeled per WEEE (Waste Electrical and Electronic Equipment) Directive

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